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Communicating nascent design theories on innovative information systems through multi-grounded design principles

Peter Heinrich, Gerhard Schwabe

University of Zurich, Binzmuehlestrasse 14, 8050 Zurich, Switzerland
{peterhe,schwabe}@ifi.uzh.ch

Abstract. One central goal of design science research (DSR) is to generate, extract and communicate knowledge about the design of an artifact. Design science researchers ultimately strive to contribute knowledge in the form of mature design theories; mere descriptions of the artifacts are not regarded as sufficient contributions to knowledge anymore in scholarly publications. There is an increasing body of guidelines on how to produce and publish mature design theories. However, not every research project is in that state. To publish intermediate results (i.e. nascent theories), only general, abstract publication schemes can be found in the recent literature making it difficult to publish design knowledge at that intermediate level. In this paper, we contribute an extension of an existing publication scheme, tailored towards the publication of such intermediate, work in progress design knowledge in the form of prescriptive design principles. This scheme was designed with respect to the complexity of today's information systems IT artifacts. To demonstrate the scheme's applicability, we will apply it to one of our recent scholarly publications in the CSCW area. We argue that this publication scheme extension will help to communicate design knowledge in earlier project stages, which allows a faster feedback to the knowledge base that will enable a broader community to participate in the "search process" for an optimal design solution.

Keywords. Design science research publications, design principles, design theory

1 Introduction

Design oriented research is well established in IS research, particularly in Europe [1]. There is a vast body of literature that generally describes DSR in theory as well as in practice (i.e. [2–5]). There is general consensus that design science focuses on the acquisition of new knowledge through the design and evaluation of artifacts. "The fundamental principle of design science research is that knowledge and understanding of a design problem and its solution are acquired in the building and application of an artifact."[6]. But when it comes to practical research projects, the definition of what design science exactly is, starts to blur. The existing publication guidelines aim to be applicable for a wide variety of fields, methods and artifacts and therefore lack specificity required to stringently describe practical projects in specific fields. Baskerville [7] highlighted the current ambiguities and misunderstandings by filling most of the space in an editorial describing what design science is not [7] and he is using one paragraph to advise the reader to make up their own minds by treating the DSR related articles in that journal issue as "best examples". Moreover, Gregor et al. [8] conclude that there is still a lack of clear understanding what defines a contribution to knowledge in the publications from DSR projects. To address the aforementioned problem, Gregor et al.'s article [8] provides a detailed framework for knowledge contributions and a schema for publishing DSR projects but in the end stays on an abstract level in order to be applicable to all kinds of practical DSR work.

For more mature knowledge however, i.e. design theories, there are several guidelines available [9, 10] on how to publish them, but not every research project is in that mature state. But as design science is regarded as an ongoing "search process" [2], it is from our point of view vital that design knowledge is contributed to the community especially in early stages. Otherwise the search process would be carried out by individuals rather than within a larger community.

Therefore, this paper aims to close that gap by extending Gregor et al. [8] in order to give specific guidance on the description of the artifacts and their design rationales with a focus on innovative information systems. Thus, the over all objective for that schema extension is to *foster the publication of nascent design knowledge in scholarly publications*. (In DSR terminology, this could also be called solution objective for the artifact, as discussed later in this article.)

This is a rather practical goal. However, by working on an artifact to reach this goal we can also contribute to the scientific knowledge base of DSR with its stream of literature on the publication of DSR results. The research question therefore addresses a gap in the current body of literature:

Research Question: *How can early design knowledge on information systems artifacts be rigorously communicated through nascent design theories at any time in the research process?*

To motivate the need for an extended DSR publication schema we report shortly on our experiences in communicating DSR. The past DSR activities in our research group often targeted the design of innovative IT artifacts in collaborative work environments like advisory service encounters. Although we (and our research group) published DSR related articles in the past years in the domain of travel agencies [11, 12] and the financial industry [13–15], we often faced a number of problems during the writing process, which sometimes even hindered the publication of valuable design knowledge. (1) During the course of such a projects, design knowledge exists at various levels of maturity at any given point in time (i.e. the time of writing). When publishing results from DSR activities we were often obliged to communicate knowledge with different levels of maturity simultaneously in order to describe our artifact and its design rationales stringently. However, we found it challenging to mix those levels of maturity while demonstrating overall rigor in a publication. (2) As the design space of possible artifacts is very large, it is in general impossible to address all design decisions in one single publication. Thus a selection of design aspects targeting the specified design goals have to be made and communicated transparently in order to avoid an impression of a random selection to readers. (3) As DSR activities are typically performed in a cyclic sequences [3] knowledge materializes at different stages in the process. This often does not seem to fit well into generic and linear structure of DSR publication schemas.

To address those problems, we will discuss the current literature on publishing DSR contributions to knowledge with a focus on designing and implementing IT-artifacts in real world contexts. We contextualize the current literature and existing publication schemes with our observed practical publication challenges and identify existing gaps. We then review the related literature and identify the necessary components and constructs to base the proposed framework upon. The main contribution of this article is the extended publication schema based on Gregor et al. [8] and a demonstration of its application to one of our previous research projects. The paper ends with a discussion of the proposed schema and its value to future research.

2 Related Work

The discussion of how to publish design knowledge already started decades ago. Walls et al. [16] provided a first structure for design theories. Walls et al.'s design theories were structured around 4 major components: "meta-requirements", "meta-design", "kernel theories", and "testable design hypothesis". The first component "meta-requirements" covers the description of the system objectives. The word "meta" was used to distinguish the project specific requirements from the more generic or abstract requirements covering the class of problems a design theory addresses [16]. The second component, the "meta-design", deals with describing the design abstractions, describing the essential rationales of the design solution. Again, the "meta"-prefix distinguishes the concrete artifact instantiation form its more generic or abstract counterpart in the design theory, that addresses a whole class of systems [16]. The third component, "kernel-theories" are meant to include justificatory knowledge for the developed theories. The fourth and last component, "testable design hypothesis", is used to provide evaluation criteria for the meta-design with respect to the meta-requirements [16].

Gregor et al. [8], also incorporating the work of Walls et al., developed a much more practical and recent framework for presenting design science research. This general framework provides a structure for complete DSR articles and includes the sections *introduction, background, method, artifact description, evaluation, discussion and conclusion*. For each section, the authors prescribe the nature of the expected content. However, as the article strives to addresses all possible kinds DSR projects, the descriptions are on an abstract and generic level. While most of the framework's sections may be directly applicable in many practical research projects, at least two of them are currently too general to be directly applicable. One of them is the "description of the artifact". In this section, the authors are required to give a "[…] concise description of the artifact at the appropriate level of abstraction […]" [8]. But no guidance is given on how to describe the design of a complex information system. The other too generic section is the discussion section, where in the case of complex socio-technical systems an "[…] explicit extraction of design principles may be needed" [8]. There, too, no guidance is given on how to publish information in a rigorous way. Arguably, both sections might be the most important ones when it comes to demonstrating a contribution to knowledge using Gregor et al.'s publication scheme, especially as it is key to demonstrate an appropriate level of rigor [2] in such work. Gregor et al. [8] address that challenge by proposing two frameworks to categorize scholarly articles by (i.) the type of knowledge contribution, and (ii.) the level of knowledge maturity (and hence abstraction). The frameworks provide three categories for knowledge maturity (ranging from "situated artifact instantiation" to "mature design theories"), and four categories of knowledge contribution types ("routine design", "improvement", "exaptation" and "invention"). Kuechler et al. [17] published a framework to support the generation of intermediate design theories. They coined the term DREPT ("design relevant explanatory / predictive theory") to describe that type of theoretical knowledge. While providing a detailed framework to support theory generation from an epistemological and thus justificatory point of view, only sparse guidance is given on how to publish those results.

When designing innovative information systems in practice, many design decisions have to be made. Scholarly publications (should) ideally convey that design knowledge by extracting the essence of those innovative design factors. However, we found it hard to classify them into one distinct category of Gregor et al.'s frameworks [8]. On one hand, as for any innovative system of real world complexity, not all design decisions are justifiable by existing prior knowledge (or have been decided upon consciously or intentionally at all). If all design decisions were completely justifiable by prior knowledge, it would not be possible anymore to contribute to scientific knowledge bases as no new knowledge could be added. Such designs would be categorized as "routine design" and would be unpublishable by definition [8]. Thus, frameworks like [17] are not even applicable to portions of the design space, as the design knowledge is just to immature. On the other hand, based on our practical experience, it seems not even possible to fully describe the design for a class of systems within a single category of knowledge contribution or knowledge maturity. Knowledge contributions of real world systems are rather likely to fall into several (if not all) categories simultaneously. Some aspects of the system might be routine design (i.e. using existing platform libraries) while others might be transferred from foreign domains (exaptations) while still others might be improved versions of previously implemented constructs (improvements). A lack of clarity at this level could be a severe thread to the overall impression of the publication's rigor if not properly explicated.

A similar issue arises with communicating practical design knowledge on different levels of maturity. Gregor et al. [8] have developed a hierarchy of maturity levels, ranging from “artifact instantiation” up to “mature theories”. However, as we often face the need to describe whole classes of information systems, it is again unlikely for a publication to only transport knowledge at one distinct level of maturity. But apart from that practical aspect, presenting abstract and generic knowledge (like design theories) also requires the description of the actual instantiation of an artifact [9]. Therefore, even publications that cover very mature knowledge are also likely to present knowledge at lower levels of maturity at the same time.

Thus we see the need to express the type of knowledge contribution as well as its maturity on a finer level of granularity in a publication.

2.1 Maturing of knowledge within a DSR project’s lifecycle

The design of innovative systems will always include a creative part of the designer (see Figure 1). Most likely, the creative part of the designer will be large when the project is novel and only little mature design knowledge is available. At any given time during a project’s lifecycle, only parts of the design decisions can be justified through existing principles or (more mature) theories, while the rest is not (yet) formalized and thus can only be attributed to a designer’s intuition (which equals intentionally taken design decisions) or is unconsciously made (which reflects the lowest level of maturity). One main concern of DSR is to formalize that “practical knowledge” [18] and thus transform the design knowledge into more mature forms. Gregor et al. [19] describe those transformations in maturity level as “passive causal analysis”, where the effects of unconscious design decisions unfold during the evaluation and “abstraction and reflection” as a process of transforming intentional design decisions into more abstract representations such as design principles. As DSR projects typically encompass several build/evaluate cycles [3] design knowledge can mature with each iteration.

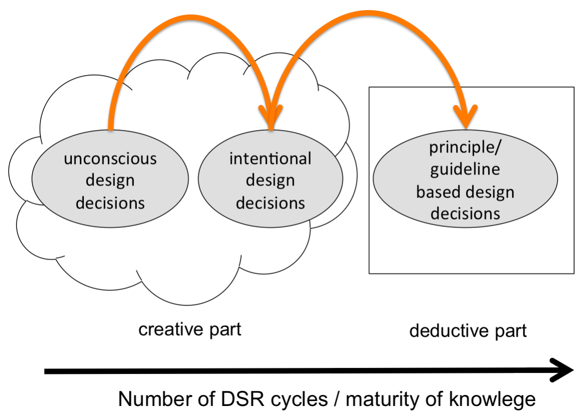

Fig. 1. Flow of design decisions through maturity levels over time

However, to present a complete picture of the state of knowledge within a certain domain, we therefore see the need for a structure that allows the publication of a snapshot of the design-knowledge at any given time in a project in order to comprehensively describe the artifacts design rationales.

2.2 Design principles as a way to encapsulate entities of design knowledge

To accomplish the task of encapsulating design knowledge of mixed levels of maturity and forms of contribution, we will use the concept of "design principles" as the primary format for formalizing design knowledge. At first glance, "design principles" seem to be a well-known and accepted form to convey design knowledge in design theories [10]. Gregor et al. acknowledge design principles as one way amongst others to communicate nascent design knowledge [8] as well as a corner piece of knowledge communication within mature design theories [9].

Van den Akker [20] offers the following generic structure of a design principle: "If you want to design intervention X (for the purpose/function Y in context Z), then you are best advised to give that intervention the characteristics A, B, and C (substantive emphasis), and to do that via procedures K, L, and M (procedural emphasis), because of arguments P, Q, and R." [20]. Depending on the nature of the design principle it may or may not be necessary to include both ABC as well as KLM. When the design principle focuses on process aspects KLM might be appropriated, where ABC may be more relevant when system features are to be described. PQR provide the grounding for the design principle.

However, this structure contains no explication of either the maturity level or the type of knowledge contribution per se. One candidate to operationalize the maturity level of a single design principle is its level of justification. For design principles used within design theories, Goldkuhl [18] suggests different forms of possible justification which he termed "grounding" that helps justify "theorized practical knowledge". The four grounding strategies are displayed in Figure 2 and a short summary of each strategy will be given in the following.

Conceptual grounding: Conceptual grounding is adequately expressed when all the concepts and phenomena related to a prescribed action and its goals are precisely defined through definitions and reasoning [18].

Value grounding: For every prescribed action a clear reference to an addressed goal should be presented, and, at the same time, the measure of goal achievement must be described [18].

Explanatory grounding: Justification for the prescriptive statements can be given through the incorporation of abstract theories, for example, like "kernel-theories" [18]. Kuechler et al. [17] provide a detailed description of how those external theories are epistemologically related with prescriptive or explanatory statements.

Empirical grounding: Through empirical grounding (in terms of instantiation and evaluation of the prescribed action) it can be investigated whether or not the prescribed action works in practice [18].

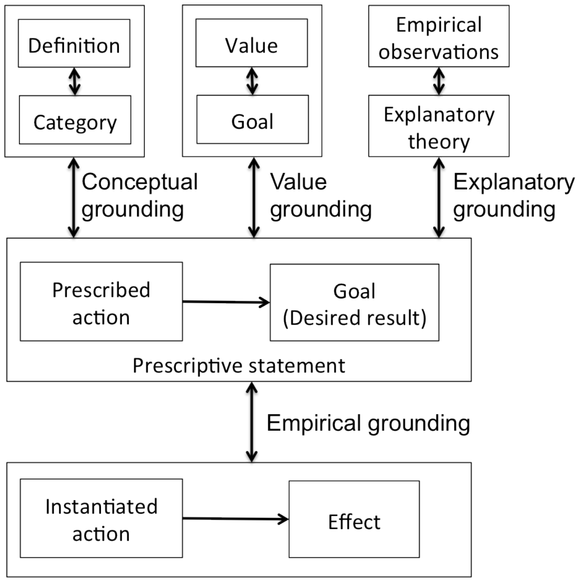

Fig. 2. Grounding of prescriptive statements (Goldkuhl [18])

As previously discussed, empirical grounding can be used to evaluate previously formalized design knowledge or give rise to completely new insights during the evaluation's execution [19]. From an epistemological point of view these are different evaluation strategies. Pries-Heje et al. [21] describe those different forms of evaluation for DSR projects in detail. An evaluation (in the sense of Goldkhul's empirical grounding) can only be of "ex-post" type, as the design principle has to be instantiated in the artifact to be testable. However, especially for multi-cycle DSR settings, the authors of [21] acknowledge the same evaluation also to be of the "ex-ante" type with respect to subsequent evaluations. To avoid any confusion within publication of DSR results, we see the need to clearly explicate the epistemological type of evaluation used, especially if one evaluation is used as "ex-post" type to provide empirical grounding as well as "ex-ante" type to derive new insights within the same publication.

3 Method

For this article, the method of design science research is applied, too. We follow the methodological step described by Peffers [4] involving the following activities: (1)

Problem identification and motivation, (2) *Define the objectives for a solution*, (3) *Design and development*, (4) *Demonstration*, (5) *Evaluation*, (6) *Communication*. In this article, we apply this methodology as follows: In the introduction section we motivate (1) the problem from a practical perspective and define the central solution objective of the artifact. After reviewing the existing literature associated with the problem, we derive the requirements for the artifact (which is, in our case, the publication scheme) (2). Based on the background literature we develop the publication scheme (artifact) (3). We demonstrate (4) the artifact's applicability by following the publication scheme's structure with one of our previously published scholarly articles. The artifact is evaluated (5) by demonstrating one successful application with the aforementioned publication and by logic argumentation (discussion section) of why that artifact solves the described problems. This article fulfills the purpose of communicating the results (6).

4 Developing the publication schema

To guide the development of an appropriate publication scheme, we first synthesize a set of meta-requirements (MRQs), summing up our initial practical problem discussed within the context of the related work:

MRQ1: *The publication scheme shall allow the simultaneous presentation of design knowledge at different levels of maturity.*

MRQ2: *The scheme should clearly explicate the type of the contribution as well as the level of rigor that is available for each contribution to design knowledge.*

MRQ3: *The scheme should clearly explicate the selection process for the design knowledge.*

MRQ4: *The publication scheme shall allow the presentation of design knowledge from both, ex-ante and ex-post, abstractions simultaneously.*

To express the rationales for design decisions within a DSR project, we propose the structure in Figure 3. This structure emerged by combining the work of Walls et al. [16], Goldkuhl et al. [18], Gregor et al.[8, 19] and Kuechler et al. [17]. From top-down, and according to Walls et al.[16], *solution objectives* (SO) should be defined for the whole socio-technical system in question. A clear argumentation of why that objective is important in a certain context is mandatory. Walls et al. suggest to define the class of problems the design theory addresses through the definition of meta-requirements for the artifact. We argue, that Walls et al.'s meta-requirements are just refinements to the solution objectives as defined before. Thus they should be derivable from them. This is expressed in Figure 3 by the use of dashed arrows representing the semantics of "derived from" to link *meta-requirements* to solution objectives.

Continuing our description of Figure 3 from bottom-up, we now focus on *the instantiated design decisions*. Gregor et al. [8, 19] describe the different maturity levels for both, practical design decisions as well as for their abstract justification in the form of nascent theories containing principles or mature design theories. Kuechler et al.'s framework [17] promotes the different types of justificatory knowledge for a given artifact construction (meta-design). The interrelation of theory components and the other entities is represented by solid black arrows having the semantic of "justified by". "Unconscious design decisions" cannot be justified ex-ante by definition, as the designer was not even aware of them. However, they might still have an influence (represented by gray arrows) on the achievement of solution objectives.

Goldkuhl's grounding strategies (in particular value grounding) require a link between the principles (prescriptive statements) and the solution objectives (goals). However, as meta-requirements are already directly derived from the solution objective, they seem a good anchor point to which the value grounding should be attached to. The result is a directed graph (Figure 3) where ultimately for every design decision its contribution to a solution objective is traceable, thereby providing rigorous value grounding and also conceptual grounding by interrelating relevant concepts and phenomena within the shown hierarchy.

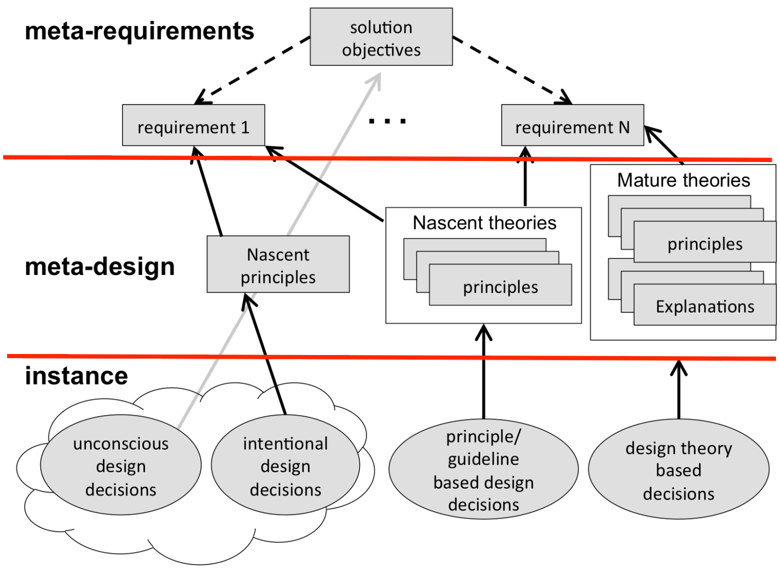

Fig. 3. Structure of entities within an immature DSR project

The central focus of this article is to cover as much of the design knowledge as possible through the formulation of design principles. Therefore, it should be an objective to provide as much grounding as possible, even for the nascent principles created through abstraction [19] from intentional design decisions. Besides the grounding provided by the described structure, further conceptual grounding can be performed by describing the domain's constructs and phenomena, the system is designed within [18], in detail. To ensure solid conceptual grounding, all those constructs and phenomena need to be defined properly. Empirical grounding can be achieved by applying the design principles in the course of the artifact's construction. Design principles are instantiated through design decision in the artifacts. Depending on the design of the evaluation, it might or might not be possible to provide direct empirical evidence to single design principles. Often, all design principles are applied altogether and the system is evaluated in terms of its solution objective achievement. This clearly is the weaker (implicit) form of empirical grounding but it is still valuable as a global indicator of success. But through observations, made during the course of evaluation, it might still be possible to draw inferences to particular design decisions, especially when they have led to problems or did not work as intended. Explanatory grounding provides one of the most rigorous forms of grounding. Strong logic argumentation and/or the use of external theories (kernel theories) [16, 18] can provide the required justification level here.

To sum up the discussion on grounding a single (nascent) design principle, we propose the structure presented in table 1 for the presentation of a multi-grounded design principle covering all described grounding strategies except of empirical grounding, because this requires the evaluation to have been executed.

Section	Contents
1. Value grounding	Describe the requirement the principle should help to fulfill.
2. Conceptual grounding	Make clear how the constructs used within the design principle interrelate with the domain objects. Clearly define any constructs not jet described.
3. Explanatory grounding	If possible, provide explanations why the design principle should work in theory. Either justify the principle by logic argument or reference existing knowledge (maybe kernel theories) presented in the background section.
4. Prescriptive statement	Precisely formulate an action that is applicable in the artifact's design.

Table 1. Proposed structure of a design principle

4.1 Proposed adapted publication schema

To give practical advice on the publication of nascent design theories through design principles, we consolidate the previous aspects discussed into one publication schema. The aim was to merge the developed structures (figure 3 and table 1) into an existing, accepted and often cited publication scheme. The resulting scheme is an adapted version of Gregor et al.'s generic template for DSR publications [8] which has been extended (formatted in italics) to integrate the previously discussed constructs:

Section	Contents
1. Introduction	Problem definition, problem significance/motivation, introduction to key concepts, research questions/objectives, scope of study, overview of methods and findings, theoretical and practical significance, structure of remainder of paper. *Definition of the solution objectives (SOs) the intervention strives to achieve with a link to already described problems. The research gap should also be given here. An outlook to the scientific contribution that emerges should be given as an outlook for the paper's discussion.*
2. Literature Review	Prior work that is relevant to the study, including theories, empirical research studies and findings/reports from practice. *If existing design-principles or design theories are used, they have to be referenced here. As a conclusion of the literature review section, the gap in current literature should be stated.*
3. Method	The research approach that was employed.
4. Communication of design knowledge	*1. Meta-Requirements (MRQs) for the artifacts with clear reference to the SOs.* *2. A list of synthesized design principles (DPs) following the structure proposed in table 1. For each DP, its instantiation in the artifact should also be described here.* *4. Representation of the artifact as a whole as good as possible (screenshots of software, photographs of the environment it is supposed to be used within, etc.)*
5. Evaluation	*Presentation of the evaluation results. Presentation of data to support or reject the fulfillment of the SOs. If data is available to support or reject individual DPs it should be presented here.*

6. Discussion	*1. Epistemologically close the loop between the sum of the design interventions and the achieved objectives.* *2. If data (observations) are available that allow inferences on more detailed levels, link them back to MRQs or DPs whenever possible. If some of the design interventions did not work as intended, give possible explanations and point out further research opportunities.* *3. If the evaluation motivates new design principle or refinements to previous ones (through the process of passive causal analysis [19]), derive new potential design principles (or refinements) here following the same structure as proposed in table 1. Of course in this case, empirical (ex-post) empirical grounding cannot be provided but may be subject for further research.*
7. Conclusion	Concluding paragraphs that restate the important findings of the work. Restates the main ideas in the contribution and why they are important.

Table 2. Publication scheme adapted from Gregor et al. [8] (Extensions and refinements are formatted in italics)

5 Application

To demonstrate how the publication schema could be applied in practices, we analyze one of our previous scholarly articles [15] that followed this structure. The article covers the topic of interpersonal relationship building when IT artifacts are collaboratively used in a dyadic setting. It communicates the results of a multi-cycle DSR project in the financial sector. In particular, that article contributes meta-requirements and design principles for IT-artifacts supporting interpersonal relationship building in financial advisory service encounter. As the research was carried out in a two-cycle DSR process, the scheme was slightly adapted to present the results in a cohesive manner. We will shortly discuss the structure of the article along the sections of the extended publication scheme (table 2):

Introduction: In the introduction we briefly motivate the necessity to understand relationship-building in technology supported service encounters. A research question is formulated accordingly and a very rough outline of the paper is presented. Furthermore, the cyclic DSR setting is outlined and the specific structure of this DSR project is sketched as: build-evaluate (prototype 1) → abstraction & conceptualization → build/evaluate (prototype 2). As in this case the solution objective is justified by the empirical findings originating from the first evaluation, its presentation has been shifted to the "Communication of Design Knowledge" section.

Literature review: The relevant literature covering the role of IT-artifacts in advisory encounters as well as literature covering relationship building in face-to-face collaboration is presented here. The design and primary evaluation of the first prototype was presented (in a seperate section) directly after the literature review part, as it was already published. However, for the purpose of that publication, the original evaluation of the first prototype was extended by the (previously unpublished) results regarding the failed relationship building aspect.

Communication of Design Knowledge: This section was split into two parts (meta-requirements / meta-design & instantiation) to ease the reading. In a first step, the solution objective of the artifact was presented: "Establish effortless relationship building in IT supported face2face advisory encounters". From there on, the (meta-) requirements are derived from three sources: existing literature, observations during the first evaluation, and a newly developed model of failed relationship building attempts. The derived requirements covered the design artifacts software, physical setting (environment), and process (organizational structure). Five meta-requirements were presented. One sample meta-requirement (originally called generic requirement in that article) governing the environmental aspects was: "*The physical effort to switch into the relationship building space has to be low. Avoid the need for body movement at all."* For each requirement, justification was given by means of referencing existing literature, the developed model or the evaluation observations (notably the first evaluation which was treated as an ex-ante evaluation).

In the meta-design & instantiation part, design-principles were presented and their instantiation within the artifact was described. Every design principle references at least one requirement and thereby provides value grounding. We strived for proper conceptual grounding by assuring that all constructs and entities were explained in the previous sections. Explanatory grounding was given in the form of logic argumentation. One sample design principle was: "Design-Principle 3 (to address generic requirement 3 and 5): Place the participants on adjacent sides around the table so that the RBS and AWS are reachable with minimal body and head movement. "[1]. Through the reference of the requirements value grounding is provided. To provide explanatory grounding, the relevant literature in the "literature-review" section is referenced directly with the design principle. To prepare the empirical grounding, explanations on the specific instantiation is given directly after the description of the principle: "[…] we raised the table by 15 cm to a comfortable height of approx. 70 cm. This allowed the participants to sit in a slightly tilted, diagonal position and use the table as an arm rest […]. "

Evaluation: The evaluation contained a qualitative part of observations and interviews made with the participants as well as a quantitative measure of relationship

[1] RBS and AWS are abbreviations of two (physical) states, participants could be within. Either a person works on the artifact (AWS) or he engages in relationship building (RBS) by seeking eye contact with the other person.

building. Relationship building was operationalized indirectly by the time the participants mutually face gazed. From video recordings of the settings the gaze durations were sampled and compared between the two prototypes.

Discussion: In this section the results were discussed with respect to the overall solution objective as well as with respect to the previously defined requirements. We could demonstrate that the prototype, with our design principles implemented, could meet the solution objectives. However, a rigorous empirical grounding for individual design principles could not be achieved with the evaluation design used, as discussed in the limitations section.

6 Discussion and conclusion

By applying the presented publication scheme, and its inner structure of the design principles to scholarly publications, we can address the practical problems discussed in the introduction. The problem of mixed knowledge maturity levels vanishes, as the scheme foresees design principles to communicate design knowledge, which can be formulated at all levels of maturity. The maturity of design principles can be explicated by their degree of justification, thereby not threatening the overall impression of rigor for the whole publication if only some design principles are immature. If all grounding strategies are successfully instantiated for all presented design principles, strongest rigor is demonstrated at this level. The selection of requirements for publications now follows a clear process: A requirement is included within a publication if design decisions (which are prescribed in the form of design principles) address it and at the same time the requirement is derivable from one or more of the presented solution objective. The structure explicitly foresees the communication of ex-ante and ex-post knowledge creation, while being always transparent on the rigor, and, thus, also on the maturity level of the communicated knowledge.

As we have shown in this article, it is likely for any practical DSR project to incorporate design knowledge on different levels of maturity on the meta-design level. However, also on the meta-requirements level, knowledge of different maturity levels can be incorporated. In the case of this article, the meta-requirements are derived form practical problems and gaps in the current literature. All meta-requirements address the central solution objective to "foster the publication of nascent design knowledge in scholarly publications".

From a DSR perspective, this article can also be seen as a nascent design theory by itself. This article provides central design principles on how to publish nascent design theories. The statement "Use the proposed structure in order to publish design knowledge" is prescriptive in a way that it suggests an action and formulates the desired goal. We provided proper grounding throughout the article by applying the described grounding methods: First, by a clear introduction of the relevant concepts based on existing literature. Second, conceptual grounding was provided for all relevant constructs used in the publication scheme. Third, value grounding was achieved by describing a desired goal, motivated by practical problems, and why that goal is important to the community. Fourth, only little explanatory grounding is provided, as it would involve theoretical models of how the publication process within the scientific community works and why. Most reasoning for the structure and constructs within the scheme are therefore of "conceptual grounding" or "value grounding" type. Empirical grounding is provided in the form of "proof by construction" [22] (also mentioned in Hevner [2]), as we presented one article that we could published with that structure applied.

Nevertheless, the empirical grounding in this article has to be treated as ex-ante evaluation because a large empirical base of published (or rejected) articles is still missing. Hence the design knowledge communicated within this article is at an intermediate maturity level and further research might be necessary to provide stronger (i.e. empirical) justification as well as refinements and adaptions to the described publication schema following the spirit of DSR as a "search process" carried out by the community.

In this paper we have discussed several practical writing problems of DSR related articles. By reviewing publication guidelines found in current literature, we identified a lack of specificity to describe design knowledge of practical DSR projects. Based on the literature on the concepts and methods of design research we derived a conceptual framework to arrange the knowledge entities within a publication (figure 3) in order to foster "conceptual grounding" [18] and "value grounding" [18] within those publications. The central entities of that schema are design principles as a way of formalizing design knowledge as prescriptive statements. We then applied the notion of multi-grounding from Goldkuhl et al. [18] to express the maturity level of a single design principle in terms of its "degree of grounding". To anchor those multi-grounded knowledge descriptions within a publication schema, we extended an existing scheme [8]. As a first instantiation, we could present one scholarly article that has been published following the prescribed structure. Hence, with this article we contribute a publication scheme that addresses our practical publication problems by providing a step-by-step guideline to publish design knowledge at any level of maturity and in any stage for practical DSR projects on innovative IT artifacts.

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